CLAIMS

1. Apparatus for treatment of a vascular bifurcation, where a first blood vessel meets a second blood vessel, the apparatus comprising a balloon for deployment at the vascular bifurcation, the balloon comprising:

a first part, which has a first inflation characteristic and is adapted to be deployed in the first blood vessel; and

a second part, which has a second inflation characteristic, different from the first inflation characteristic, and is adapted to be deployed in the second blood vessel.

2. The apparatus according to claim 1, wherein the second part is adapted to protrude radially from the first part when the balloon is inflated.

3. The apparatus according to claim 2, wherein the second part is adapted, upon partial inflation of the balloon, to extend into the second blood vessel so as to facilitate alignment of the balloon with the vascular bifurcation.

4. The apparatus according to claim 2, wherein the second part comprises a fan-fold, which is adapted to unfold upon inflation of the balloon so that the second part extends into the second blood vessel.

5. The apparatus according to claim 2, wherein while the balloon is deflated, at least a portion of the second part is contained inside the first part, and wherein the second part is adapted to extend outward from the first part upon inflation of the balloon.

6. The apparatus according to claim 2, and comprising a retraction mechanism, which is coupled to the second part so as to retract the second part radially toward the first part upon deflation of the balloon.

7. The apparatus according to claim 2, and comprising a radiopaque marker in at least a portion of the second part, wherein the marker is configured so as to permit visualization of an alignment of the balloon relative to the bifurcation under angiographic imaging.

8. The apparatus according to claim 7, wherein the radiopaque marker comprises a ring encircling the second part.

9. The apparatus according to claim 2, and comprising a stent, which is fitted over the first part of the balloon and is adapted to be deployed within the first blood vessel by inflation of the balloon, wherein the stent has a radial opening to permit access between the first and

second blood vessels, and wherein the second part of the balloon is adapted to protrude radially through the radial opening in the stent.

10. The apparatus according to claim 9, wherein the stent is adapted to elute a therapeutic substance.

11. The apparatus according to claim 1, wherein the inflation characteristic comprises a degree of compliance, such that the first and second parts of the balloon have different, respective degrees of compliance.

12. The apparatus according to claim 11, wherein the second part of the balloon comprises a sleeve, which is secured over a portion of the first part of the balloon so as to constrain the compliance of the portion of the first part.

13. The apparatus according to claim 1, wherein the first and second blood vessels have characteristic first and second diameters, wherein the first diameter is greater than the second diameter, and wherein the first part of the balloon is adapted, upon inflation of the balloon while the second part is deployed in the second blood vessel, to assume an expanded diameter greater than the second diameter.

14. The apparatus according to claim 13, wherein the first part of the balloon is configured as a collar around the second part of the balloon when the balloon is inflated.

15. The apparatus according to claim 14, wherein the first part of the balloon comprises a toroid, which surrounds a portion of the second part of the balloon.

16. The apparatus according to claim 13, wherein the first part of the balloon is adapted, upon the inflation of the balloon, to engage an ostium.

17. The apparatus according to claim 16, and comprising a stent, which is fitted over the second part of the balloon and is adapted to be deployed within the second blood vessel by the inflation of the balloon, the stent comprising a proximal end that is adapted to be expanded to a size greater than the second diameter, and wherein the first part of the balloon is adapted to expand the proximal end of the stent so as to anchor the proximal end against the ostium.

18. The apparatus according to claim 17, wherein the proximal end of the stent comprises a plurality of struts, which are configured to be expanded to the size greater than the second diameter.

19. The apparatus according to claim 17, wherein the stent is adapted to elute a therapeutic substance.

20. The apparatus according to claim 16, and comprising a stent, which is fitted over the second part of the balloon and is adapted to be deployed within the second blood vessel by the inflation of the second part of the balloon, and wherein the first part of the balloon, when expanded, is adapted to serve as a stop against the ostium so as to aid in alignment of the stent within the second blood vessel.

21. The apparatus according to claim 20, wherein the stent is adapted to elute a therapeutic substance.

22. The apparatus according to any of claims 1-21, wherein at least one of the first and second parts of the balloon has a lumen passing therethrough to accommodate a guide wire used in the deployment of the balloon.

23. The apparatus according to claim 22, wherein no more than one of the first and second parts of the balloon has the lumen passing therethrough.

24. The apparatus according to any of claims 1-21, wherein the first and second parts of the balloon share a common inflation port.

25. The apparatus according to any of claims 1-21, wherein the first and second parts of the balloon have separate, respective inflation ports.

26. A method for treatment of a vascular bifurcation, where a first blood vessel meets a second blood vessel, the method comprising:

providing a balloon comprising a first part, which has a first inflation characteristic, and a second part, which has a second inflation characteristic, different from the first inflation characteristic;

deploying the balloon at the vascular bifurcation, such that the first part is deployed in the first blood vessel and the second part is deployed in the second blood vessel; and

inflating the first and second parts of the balloon within the first and second blood vessels, respectively.

27. The method according to claim 26, wherein the second part is adapted to protrude radially from the first part when the balloon is inflated.

28. The method according to claim 27, wherein deploying the balloon comprises partially inflating the balloon so that the second part protrudes radially away from the first part, and aligning the partially-inflated balloon using the second part before completely inflating the balloon.

29. The method according to claim 27, wherein the second part comprises a fan-fold, and wherein inflating the first and second parts comprises unfolding the fan-fold so that the second part extends into the second blood vessel.

30. The method according to claim 27, wherein while the balloon is deflated, at least a portion of the second part is contained inside the first part, and wherein inflating the first and second parts causes the second part to extend outward from the first part.

31. The method according to claim 27, and comprising retracting the second part radially toward the first part upon deflation of the balloon.

32. The method according to claim 27, wherein a radiopaque marker is positioned in at least a portion of the second part, and wherein deploying the balloon comprises using the marker under angiographic imaging so as to visualize of an alignment of the balloon relative to the bifurcation.

33. The method according to claim 32, wherein the radiopaque marker comprises a ring encircling the second part.

34. The method according to claim 27, and comprising fitting a stent over the first part of the balloon, wherein the stent has a radial opening to permit access between the first and second blood vessels, wherein inflating the first and second parts of the balloon comprises deploying the stent within the first blood vessel by inflation of the balloon, which causes the second part of the balloon to protrude radially into the second blood vessel through the radial opening in the stent.

35. The method according to claim 34, wherein the stent is adapted to elute a therapeutic substance.

36. The method according to claim 26, wherein the inflation characteristic comprises a degree of compliance, such that the first and second parts of the balloon have different, respective degrees of compliance.

37. The method according to claim 36, wherein the second part of the balloon comprises a sleeve, which is secured over a portion of the first part of the balloon so as to constrain the compliance of the portion of the first part.

38. The method according to claim 26, wherein the first and second blood vessels have characteristic first and second diameters, wherein the first diameter is greater than the second diameter, and wherein inflating the first and second parts of the balloon comprises inflating the first part to an expanded diameter greater than the second diameter.

39. The method according to claim 38, wherein the first part of the balloon is configured as a collar around the second part of the balloon when the first part of the balloon is inflated.

40. The method according to claim 39, wherein the first part of the balloon comprises a toroid, which surrounds a portion of the second part of the balloon.

41. The method according to claim 38, wherein deploying the balloon comprises positioning the balloon so that upon inflation of the balloon, the first part of the balloon engages an ostium.

42. The method according to claim 41, and comprising fitting a stent over the second part of the balloon, wherein inflating the first and second parts of the balloon comprises deploying the stent within the second blood vessel by the inflation of the second part of the balloon, while expanding a proximal end of the stent to a size greater than the second diameter by the inflation of the first part of the balloon so as to anchor the proximal end against the ostium.

43. The method according to claim 42, wherein the proximal end of the stent comprises a plurality of struts, and wherein expanding the proximal end comprises spreading the struts.

44. The method according to claim 42, wherein the stent is adapted to elute a therapeutic substance.

45. The method according to claim 41, and comprising fitting a stent over the second part of the balloon, wherein positioning the balloon comprises:

aligning the stent on the second part of the balloon inside the second blood vessel after inflating the first part of the balloon to the expanded diameter, so that the first part of the balloon serves as a stop against the ostium; and

after aligning the second part of the balloon, expanding the second part of the balloon so as to deploy the stent within the second blood vessel.

46. The method according to claim 45, wherein the stent is adapted to elute a therapeutic substance.

47. The method according to any of claims 26-46, wherein deploying the balloon comprises passing a guide wire through a lumen in at least one of the first and second parts of the balloon, and deploying the balloon at the vascular bifurcation over the guide wire.

48. The method according to claim 47, wherein no more than one of the first and second parts of the balloon has the lumen passing therethrough.

49. The method according to any of claims 26-46, wherein inflating the first and second parts of the balloon comprises inflating both of the parts of the balloon through a common inflation port.

50. The method according to any of claims 26-46, wherein inflating the first and second parts of the balloon comprises inflating the first and second parts of the balloon through separate, respective inflation ports.

51. Apparatus for treatment of a vascular bifurcation, where a first blood vessel meets a second blood vessel, the apparatus comprising:

a balloon for deployment at the vascular bifurcation, the balloon comprising a first part, which has a first inflation characteristic and is adapted to be deployed in the first blood vessel, and a second part, which has a second inflation characteristic, different from the first inflation characteristic, and is adapted to be deployed in the second blood vessel; and

a catheter, having a distal end to which the balloon is coupled, and which is adapted to pass through the first blood vessel so as to deploy the balloon at the bifurcation.

52. A method for manufacturing an intravascular balloon, comprising:

fabricating a first part of the balloon so as to have a first inflation characteristic; and

fabricating a second part of the balloon, coupled to the first part, so as to have a second inflation characteristic, which is different from the first inflation characteristic.

53. The method according to claim 52, wherein fabricating the second part of the balloon comprises fabricating the second part as a bifurcation from the first part.

54. The method according to claim 52, wherein fabricating the second part of the balloon so that the first part forms a collar around the second part when the balloon is inflated.

55. The method according to claim 52, wherein the first and second inflation characteristics respectively comprise different, first and second degrees of compliance.

56. The method according to claim 55, wherein fabricating the second part of the balloon comprises securing a sleeve over a portion of the first part of the balloon so as to constrain the compliance of the portion of the first part.

57. The method according to claim 52, and comprising fitting a stent over at least one of the first and second parts of the balloon.

58. The method according to claim 52, wherein fabricating the first and second parts of the balloon comprises fabricating at least one of the first and second parts by injection molding using a bifurcated mold.

59. The method according to claim 52, wherein fabricating the first and second parts of the balloon comprises fabricating at least one of the first and second parts by blow molding using a bifurcated mold.

60. The method according to claim 59, wherein the bifurcated mold comprises a telescopic mold.

61. The method according to claim 59, wherein fabricating the at least one of the first and second parts comprises applying at least one of suction and an angled pin to direct material into the bifurcated mold.

62. The method according to claim 52, wherein fabricating the first and second parts of the balloon comprises fabricating the first and second parts by dipping a bifurcated model in a liquid polymer.

63. The method according to claim 52, wherein fabricating the first and second parts of the balloon comprises fabricating the first part of the balloon, and then applying a local treatment to an area of the first part in order to form the second part.

64. A vascular stent, comprising:

a distal section, which is adapted to be deployed and expanded within a blood vessel of a given diameter in a location adjacent to an ostium; and

a proximal section, which is adapted to be expanded against the ostium to a size greater than the given diameter so as to anchor the proximal section against the ostium.

65. The stent according to claim 64, wherein the distal section of the stent comprises a first number of struts along a perimeter of the stent, and wherein the proximal section of the stent comprises a second number of the struts, greater than the first number.

66. The stent according to claim 64, wherein the proximal section comprises a plurality of struts, which are configured to bend outward so as to engage the ostium.

67. The stent according to any of claims 64-66, wherein at least one of the distal and proximal sections is adapted to elute a therapeutic substance.

68. Apparatus for treatment of a vascular bifurcation, where a first blood vessel meets a second blood vessel, the apparatus comprising a balloon for deployment at the vascular bifurcation, the balloon comprising:

a first part, which is adapted to be deployed in the first blood vessel; and

a second part, which is adapted to protrude radially from the first part when the balloon is inflated so as to facilitate alignment of the balloon with the vascular bifurcation.

69. The apparatus according to claim 68, and comprising a stent, which is fitted over the first part of the balloon and is adapted to be deployed within the first blood vessel by inflation of the balloon, wherein the stent has a radial opening to permit access between the first and second blood vessels, and wherein the second part of the balloon is adapted to protrude radially through the radial opening in the stent.

70. The apparatus according to claim 69, wherein the stent comprises struts over the radial opening, and wherein the second part of the balloon is adapted to open the struts outward when the balloon is inflated.

71. The apparatus according to any of claims 68-70, and comprising a radiopaque marker in at least a portion of the second part, wherein the marker is configured so as to permit visualization of an alignment of the balloon relative to the bifurcation under angiographic imaging.

72. Apparatus for treatment of a vascular bifurcation, where a first blood vessel meets a second blood vessel, wherein the first and second blood vessels have characteristic first and second diameters, wherein the first diameter is greater than the second diameter, the apparatus comprising a balloon for deployment at the vascular bifurcation, the balloon comprising:

an inner part, which is adapted to be deployed in the second blood vessel; and

a collar around the inner part, which is adapted, upon inflation of the balloon while the second part is deployed in the second blood vessel, to assume an expanded diameter greater than the second diameter.

73. The apparatus according to claim 72, wherein the collar comprises a toroid, which surrounds a portion of the inner part of the balloon.

74. The apparatus according to claim 72 or 73, wherein the collar is adapted, upon the inflation of the balloon, to engage an ostium.

75. The apparatus according to claim 74, and comprising a stent, which is fitted over the inner part of the balloon and is adapted to be deployed within the second blood vessel by the inflation of the balloon, the stent comprising a proximal end that is adapted to be expanded to a size greater than the second diameter, and wherein the collar is adapted to expand the proximal end of the stent so as to anchor the proximal end against the ostium.

76. The apparatus according to claim 74, and comprising a stent, which is fitted over the inner part of the balloon and is adapted to be deployed within the second blood vessel by the inflation of the second part of the balloon, and wherein the collar, when expanded, is adapted to serve as a stop against the ostium so as to aid in alignment of the stent within the second blood vessel.

77. A method for treatment of a vascular bifurcation, where a first blood vessel meets a second blood vessel, the method comprising:

providing a balloon comprising a first part, which has a first inflation characteristic, and a second part, which is adapted to protrude radially from the first part when the balloon is inflated;

deploying the balloon in a vicinity of the vascular bifurcation, such that the first part is deployed in the first blood vessel;

partially inflating the balloon in the vicinity of the vascular bifurcation so that the second part protrudes radially away from the first part;

aligning the second part of the partially-inflated balloon with the second blood vessel; and

fully inflating the balloon after aligning the second part.

78. The method according to claim 77, and comprising fitting a stent over the first part of the balloon, wherein the stent has a radial opening to permit access between the first and

second blood vessels, wherein fully inflating the balloon comprises deploying the stent within the first blood vessel by inflation of the balloon, which causes the second part of the balloon to protrude radially into the second blood vessel through the radial opening in the stent.

79. The method according claim 78, wherein the stent comprises struts over the radial opening, and wherein fully inflating the balloon causes the second part of the balloon to open the radial struts outward against an ostium.

80. A method for treatment of a vascular bifurcation, where a first blood vessel meets a second blood vessel, wherein the first and second blood vessels have characteristic first and second diameters, wherein the first diameter is greater than the second diameter, the method comprising:

providing a balloon comprising an inner part and a collar around the inner part;

deploying the balloon at the vascular bifurcation, such that the inner part is deployed in the first blood vessel and the collar is deployed in the second blood vessel; and

inflating the balloon so that the collar expands to an expanded diameter greater than the second diameter and engages an ostium.

81. The method according to claim 80, and comprising fitting a stent over the inner part of the balloon, wherein deploying the balloon comprises deploying the stent within the second blood vessel, and wherein inflating the balloon causes the collar to expand a proximal end of the stent to a size greater than the second diameter so as to anchor the proximal end against the ostium.

82. The method according to claim 80, and comprising fitting a stent over the inner part of the balloon, wherein deploying the balloon comprises:

aligning the stent on the inner part of the balloon inside the second blood vessel after inflating the collar to the expanded diameter, so that the collar serves as a stop against the ostium; and

after aligning the inner part of the balloon, expanding the second part of the balloon so as to deploy the stent within the second blood vessel.